



**US Army Corps
of Engineers®**
Engineer Research and
Development Center

National Erosion Control Development and Demonstration Program (Section 227)

Allegan County, MI, Bluff Study

Background

Slope failures in heterogeneous glacial soils are common within many sectors of North America affected by coastal erosion or river action. In the Great Lakes region, receding bluffs carved into glacial tills or lacustrine deposits occupy more than 60 percent of the shoreline. In coastal areas when mitigation strategies are chosen, much of the blame for slope movements is commonly placed on toe erosion although groundwater activity is sometimes a significant factor. Three sites along Lake Michigan where slope failures are frequent were selected for the demonstration project: the Miami Park South site (MPS), the Miami Park North site (MPN), and the 116th Avenue site (116th). These sites are roughly 152.4 m (500 ft) to 30.4 m (100 ft) in length and occur along the east coast of Lake Michigan, within 14.4 km (9 miles) of South Haven, MI. Western Michigan University (WMU) has monitored these sites continuously for slope movements since 1996 with a simple pole and cable survey system. To date, empirical and limit equilibrium models have demonstrated groundwater as the significant factor contributing to these observed failures. The objective of this demonstration project will be to evaluate the effectiveness of dewatering strategies (active and passive) on slope stabilization through automated monitoring of the slopes.



Boreholes are drilled for installation of slope monitoring instruments

Problem

Bluff erosion along the shore of the Great Lakes creates significant property damage and land loss each year. Traditional means to combat erosion are expensive and non-aesthetically pleasing. There was a need to develop an innovative design for slowing or stopping bluff erosion, which is less expensive and more effective.

Technology

Add active or passive dewatering systems to the bluffs for groundwater control. Dewater bluffs during winter and spring when erosion is typically occurring. Monitor bluff displacement continuously while dewatering, and while drains are dormant to measure effectiveness of the design. Simultaneously monitor control sites without dewatering measures in place, for comparison to design performance. Develop saturated and unsaturated numerical flow model of test bluff to optimize dewatering effort/energy. The numerical model will act as a design tool for other sites.

Status Surface monitoring of slope movement by pole and cable survey system is ongoing. All drilling for subsurface monitoring instrumentation has been completed. All instruments have been installed at the Miami Park south site.

Additional instrumentation has been purchased by ERDC Cold Regions Research Engineering Laboratory (CRREL) for the MPS site, consisting of five soil moisture probes at two sites (10 total), two soil resistivity probes, two thermistor strings with six thermistors per string, and two Web cams. These supplemental instruments will assist in validation of the numerical flow model. The Web cams will allow 24-hr visual monitoring of the site on the World Wide Web (www). These instruments were installed during June 2004. The Web site is <https://webcam.crrel.usace.army.mil/allegan/>

Work on a numerical flow model is just beginning. Initial versions of the model will be run using FEMWATER; current plans include building a final model using ADH. A pump test at MPS was conducted in May 2004 to derive hydraulic properties of the strata in support of the numerical model.

- Time Line**
- First year FY02 demonstration planning
 - Second year FY03 drilling and equipment purchasing
 - Third year FY04 installation of instruments, begin monitoring and start dewatering system. Prepare midproject publications
 - Fourth year, FY05, stop dewatering, continue monitoring, analyze results from dewatering and optimize dewatering system for future years.
 - Fifth year, FY06, start dewatering, continue monitoring, and develop operations manual for continued operation of dewatering system by WMU. Analyze long-term results from dewatering and prepare publications.
 - Sixth year, FY07, continue dewatering and monitoring. Release project to WMU.

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Available Documentation Chase, R. B., Kehew, A. E., and Montgomery, W. W. (2001). "Determination of slope displacement mechanisms and causes," *Landscape Erosion and Evolution Modeling*. Kluwer Academic/Plenum Publishers, New York.

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Program Authorization Water Resources and Development Act of 1996 (Public Law 104-303, 110 Stat. 3658) dated October 12, 1996.

Additional information can be found at <http://chl.erdcl.usace.army.mil/section227>.